returned to 50 from the planned level of 36, and higher purchases were slated for various air-to-air missiles.6/

Some of these increases were reduced when the authorization bill was approved by the House, to meet the defense target in the fiscal year 1988 budget resolution. The Apache quantity was reduced to 77 (still an increase of 10 over the Administration's request), and the Black Hawk quantity was set at 72 (versus 61 in the request). Other changes reduced production rates below those requested by the Administration. Procurement of AH-1W Sea Cobra helicopters was reduced from 22 units to 12 units; 2 E-6A aircraft were approved versus the 3 requested by the Administration; Rolling Airframe Missile procurement was halved (from 240 to 120); Navy purchases of IIR Maverick missiles were cut from 601 to 425; and Air Force AMRAAM purchases were reduced from 630 to 500 units.

The Senate Committee on Armed Services also noted with concern the premature terminations and stretch-outs of conventional weapons programs.7/ It recommended and the full Senate approved increases in purchases of attack and utility helicopters, M1 tanks, and Sparrow missiles, and a higher rate of KC-135R conversions. The conference agreement set these increases at or near the lower levels passed by the House.

Clearly, despite severe budget pressures, both authorizing committees feel that the benefits of higher production rates would outweigh their disadvantages. It seems unlikely, however, that the Congress will be willing to increase the dollars available for military procurement by substantial amounts. Can higher production rates be achieved without additional funding?

This study presents one approach. Chapter II reviews recent production programs to assess the severity of the low production-rate problem. Chapter III looks at the costs of stretch-outs, as well as reasons why stretch-outs occur. The final chapter presents specific options for maintaining higher rates for some systems, as well as ways to finance the near-term budget increases necessary to do so.

6. *National Defense Authorization Act for Fiscal Year 1988/1989*, Report No. 100-58, House Committee on Armed Services, 100:1 (1987), p. 9.

7. *National Defense Authorization Act for Fiscal Years 1988 and 1989*, Report No. 100-57, Senate Committee on Armed Services, 100:1 (1987), pp. 8-9.

CHAPTER II

EVALUATION OF WEAPONS PRODUCTION-RATE TRENDS

Are current weapons production rates too low? The question can be answered in several ways. One approach focuses on DoD's goal of buying weapons in sufficient quantities to bring their costs down to reasonable levels. The difficulty with this approach is that most weapons are unique products, so that norms for "reasonable" costs are difficult to establish. Ultimately, such measures must rely on educated judgments, in the absence of more formal criteria.

A second, simpler approach is to look at the direction of production-rate trends. Are production quantities lower today than they were 10 or 20 years ago? If so, this may indicate that the problem of stretch-outs and inadequately funded programs is getting worse and that DoD's efforts to reverse these trends have not been successful.

CURRENT PRODUCTION RATES COMPARED WITH DoD'S NORMS

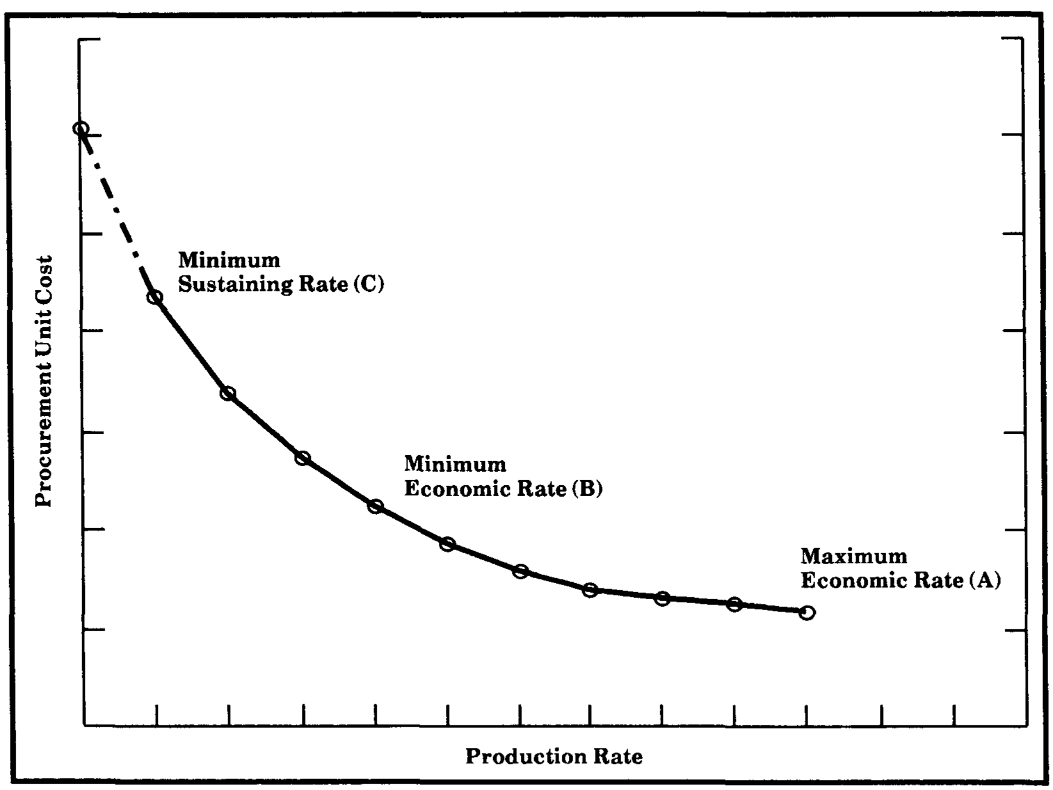
As noted previously, the Administration initially set a number of goals for improving the acquisition process. One of these was to acquire weapons systems at economic production rates. To aid in the planning and review of service acquisition requests, DoD managers in 1983 defined three measures that would be used to characterize the range of possible rates of production: the maximum and minimum economic production rates, and the minimum sustaining rate.

Definitions of Norms

The maximum economic production rate (point A in Figure 1) was defined by DoD as the highest rate of production permitted by existing plant capacity, tooling, or test equipment (or that currently planned, in the case of new systems). As the definition above indicates, the limiting factor is normally capital equipment, specifically the tools and dies used to form the parts needed to manufacture the item, or the special test equipment used to verify that the components of the system (particularly electronics) function properly.

Because of its expense, producers will often plan to use this capital intensively--sometimes even 24 hours a day, seven days a week--even though the other plant activities are run on a more limited schedule of one or two shifts, five days a week. These capital equipment items, which often take two or more years to acquire, are usually bought by the manufacturer in the early years of the program. Thus, once they are in place, plant capacity is essentially limited to the throughput they permit.

FIGURE 1. RELATIONSHIPS BETWEEN ECONOMIC PRODUCTION RATES



SOURCE: Congressional Budget Office.

The minimum economic rate (point B in Figure 1) lies somewhere below the maximum production rate. DoD defined it as the lowest rate of production that still offers an acceptable rate of return on the investment in production facilities. Alternatively, it may be selected as the point on the cost schedule below which unit costs rise at an excessive rate. Unfortunately, there is no mathematical formula to indicate when the rate of production becomes uneconomic. Service program managers and contractors have their own ideas, which do not always agree. Nevertheless, the services have previously reported minimum economic rates for a number of major systems.1/

The minimum sustaining rate (MSR--point C in Figure 1) is defined as the lowest production rate that, in the judgment of program managers, can reasonably sustain an active production base. In some cases, this is set according to the minimum feasible rate of production for one shift of workers employed five days a week. In other cases, it may be determined by the minimum level of activity of a key supplier or subcontractor rather than by that of the prime contractor, who may have other military or commercial work to fill his plant. Like the other two rate concepts, the MSR is also a matter of judgment; on occasion, DoD will buy systems in smaller quantities than would be indicated by their reported MSR. This may occur early in the program, while testing of the system is still under way, or in a late stage when maintaining an active base ceases to be of concern to DoD.

Production Rates, 1983-1987

Using these three standards, the study examined the rate of procurement for 40 major weapons systems--including aircraft, missiles, and combat vehicles, but not ships--produced in the five-year period from 1983 through 1987.2/ These systems were among the acquisition programs that received the most funding during the period. They are listed in Tables 1 and 2, together with their highest, lowest, and average annual procurement rates over the five-year period; the tables

1. DoD no longer requires managers to define the minimum economic rate as such; instead, they are to report unit costs for a range of rates.

2. Production-rate economies for ships tend to be small because of their method of construction and the small quantities in which they are produced.

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TABLE 1. SYSTEMS BOUGHT AT OR ABOVE MINIMUM ECONOMIC RATES

Weapons System	1983-1987 Annual Procurement Rates			Minimum Sustaining Rate	Minimum Economic Rate	Maximum Economic Rate
	Minimum a/	Maximum	Average a/ b/			
AH-64 Apache Helicopter	112	138	117	24	72	144
M1 Abrams Tank	790	855	825	360	720	1,080
Bradley Fighting Vehicle	600	716	647	336	540	792
Patriot Missile	287	700	485	240	240	840
Stinger Missile	1,956	6,250	3,539	1,200	1,800	11,520
F/A-18 Aircraft	84	84	84	36	84	145
Standard Missile 2 (Medium-Range)	150	846	552	n.a.	480	844
Sparrow Missile c/	1,700	2,445	2,015	600	1,200	3,804
B-1B Bomber	10	48	31	12	24	48
C-5B Transport	8	21	15	4	4	24
F-16 Aircraft	120	180	155	72	108	324
Hellfire Missile c/	4,870	7,304	6,131	1,200	1,500	6,720
Multiple Launch Rocket System	23,640	72,000	50,822	24,000	36,000	72,000
F-14A Aircraft	15	24	21	12	12	96
KC-10 Tanker/ Cargo Aircraft	8	12	9	8	8	24
C-2 Greyhound Aircraft	6	9	8	4	8	9
CH-53 Super Stallion Helicopter	10	14	12	11	12	24
EA-6B Prowler Aircraft	6	12	9	6	6	24
E-2C Hawkeye Aircraft	6	10	7	4	6	18
SH-2F Seasprite Helicopter	6	18	8	6	6	48

SOURCE: Compiled by the Congressional Budget Office from Department of Defense, *Procurement Programs (P-1)*, various years (for annual procurement rates) and from service responses to Congressional inquiries (for sustaining and economic rates).

NOTE: n.a. = not available.

a. Excludes initial two years of production.

b. Average over years within the 1983-1987 period when the system was actually procured.

c. Combined procurement of all services.

TABLE 2. SYSTEMS BOUGHT BELOW MINIMUM ECONOMIC RATES

Weapons System	1983-1987 Annual Procurement Rates Minimum a/	Maximum	Average a/ b/	Minimum Sustaining Rate	Minimum Economic Rate	Maximum Economic Rate
AV-8B Aircraft	21	46	34	30	36	72
A-6E Aircraft	6	11	8	6	12	72
F-15 Aircraft	36	48	41	48	120	144
Ground-Launched Cruise Missile	76	120	99	120	120	600
Harpoon Missile	96	439	284	180	360	660
MX Missile	12	21	17	12	21	48
P-3C Aircraft	5	9	8	6	16	24
Phoenix Missile	108	265	222	108	240	420
SH-60B LAMPS Helicopter c/	18	27	23	21	24	60
Tomahawk Missile	51	324	186	120	300	540
AMRAAM Missile d/	0	180	a/	960	960	3,600
E-6A TACAMO	2	3	a/	n.a.	4	12
HARM Missile e/	289	2,462	1,460	2,256	3,240	6,480
IIR Maverick Missile	900	2,600	2,205	4,200	6,000	10,800
Laser Maverick	90	1,800	1,300	600	1,800	3,600
EH-60 Quickfix Helicopter	12	18	17	12	24	48
Sidewinder Missile e/	1,000	3,770	2,122	1,200	2,400	8,400
Standard Missile 2 (Extended Range)	100	425	296	n.a.	360	480
TOW 2 Missile e/	12,600	20,200	15,482	12,000	21,600	30,000
UH-60 Black Hawk Helicopter	78	96	85	72	96	144

SOURCE: Compiled by the Congressional Budget Office from Department of Defense, *Procurement Programs (P-1)*, various years (for annual procurement rates) and from service responses to Congressional inquiries (for sustaining and economic rates).

NOTE: n.a. = not available.

a. Excludes initial two years of production.

b. Average over years within the 1983-1987 period when the system was actually procured.

c. Includes seven SH-60F helicopters in 1987.

d. Still in low-rate initial production phase.

e. Combined procurement of all services.

also show each program's reported minimum sustaining rate and minimum and maximum economic rates.

Table 1 lists the 20 systems (of the 40 examined) for which average annual procurement quantities over 1983-1987 matched or exceeded the minimum economic rates. (None was above its reported maximum economic rate.) Many of these may have benefited from a DoD initiative to maintain procurement at or above this minimum standard. While these data seem positive, the numbers of systems qualifying for Table 1 may have been inflated. For some aircraft, the Navy reported minimum economic rates as only six aircraft per year, a doubtfully low standard. Also, the minimum economic rate for the Air Force's C-5B was reported as only four per year.

The remaining 20 (of the 40) systems were bought at average rates below their minimum economic rate (see Table 2). For a few systems (the TOW 2, Harpoon, and Sidewinder missiles), production for foreign military sales--not reflected in these data--raised total production quantities above the minimum economic rate during this period. For the remaining systems, however, rates were below--and sometimes well below--the minimum economic levels. The F-15, for example, has a minimum economic rate of 10 aircraft per month (120 per year), but was bought at an average of 41 aircraft per year.

Production below the minimum economic rate deviates from DoD's policy of keeping production rates for major systems at or above their minimum economic rates. The Army was most successful in reaching this goal: 70 percent of the Army systems reviewed were procured at average rates over the 1983-1987 period that met or exceeded their minimum economic rates. The comparable percentages for the other services were much lower: 44 percent for the Air Force and 43 percent for the Navy.

Since the services have not always defined the minimum economic rate consistently, another approach is to examine the percentage of systems bought at 50 percent or more of their maximum economic rates. While arbitrary, this choice of 50 percent seems like a reasonable lower bound; in the private sector, production below 70 percent of capacity is often considered very low. Again, the Army did best by this measure, with nine of ten systems meeting the test. The Navy was a distant second, with only 33 percent of its systems exceed-ing 50 percent of their maximum, while the Air Force produced only two of nine systems--the C-5B transport and the B-1B bomber--at 50 percent or more of their maximum economic rates.

Indeed, substantial numbers of these systems were produced at only small fractions of their maximum economic rates. Nine of the 40 systems had average rates of production in 1983 through 1987 that were one-quarter or less of their maximum economic rates.

Perhaps the minimum test of production efficiency is whether a system is produced at its minimum sustaining rate. DoD generally attempts to maintain production of all weapons at or above this rate. Only six of the 40 systems had average rates of procurement in 1983 through 1987 that were below their minimum sustaining rates. However, for 15 of the systems, production dipped below the minimum sustaining rates for at least one year during this period. And this situation seems likely to continue. In the fiscal year 1988 budget, production of four systems was planned at lower than minimum sustaining rates: the Black Hawk helicopter (61 in 1988 versus a reported MSR of 72); the AMRAAM missile (630 versus 960); the IIR Maverick (2,701 versus 4,200); and the F-15E fighter (42 versus 48). While the AMRAAM missile's production lines are still gearing up for full-rate production, low rates for the other three programs are more difficult to justify.

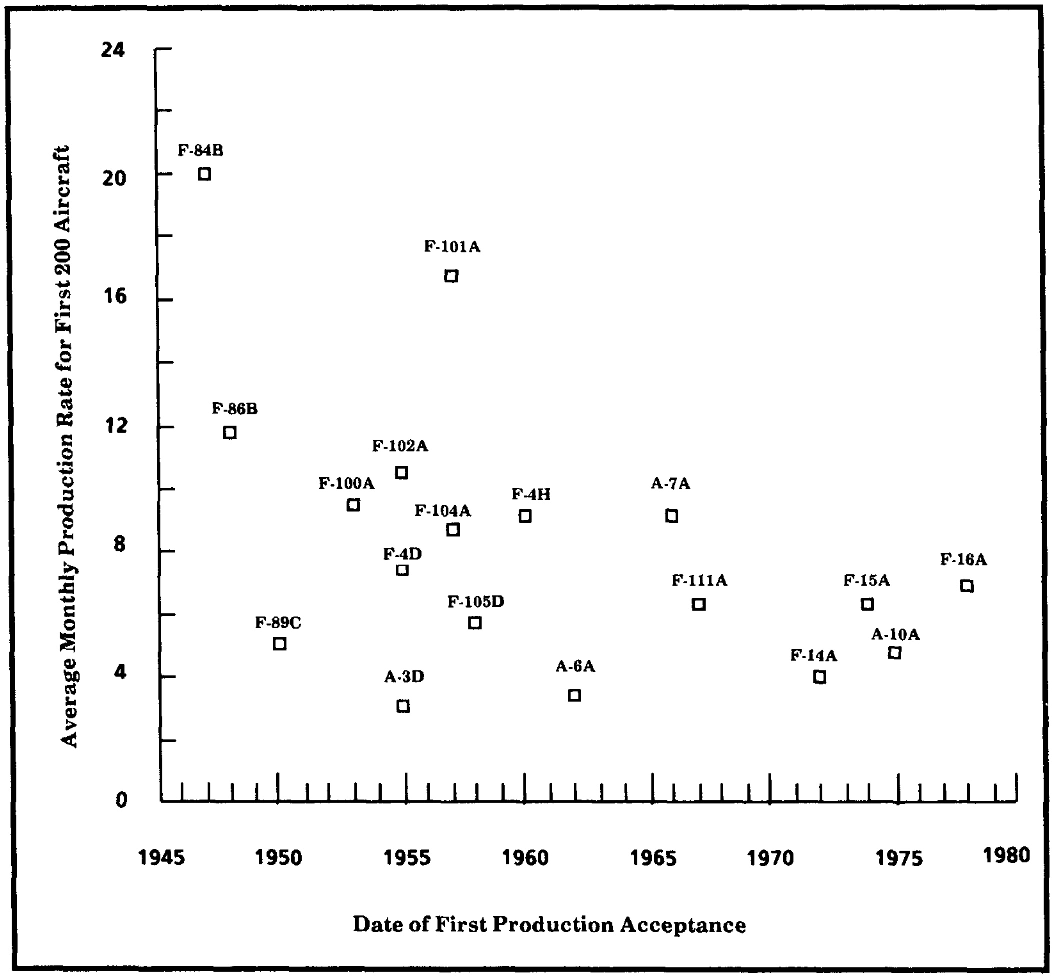
Since most systems undergo an initial period of low-rate production before building to their maximum planned rates, the above analysis has ignored the first two years of procurement in evaluating production rates. In certain cases, however, because of development or production problems, the low-rate period extended well beyond two years. This accounts for a few of the observed low rates--notably those for the AMRAAM, Phoenix, and IIR Maverick programs.

TRENDS IN WEAPONS PRODUCTION

Procurement of military aircraft has shown a distinct downward trend since the 1950s (see Figure 2). This trend is evident whether measured by annual procurement rates or by total program quantities.The primary reason for this decline is the increased real cost of aircraft, even after adjustment for inflation. Procurement budgets have not grown proportionately to the price of aircraft; reductions in annual quantities are the inevitable result.

During the 1950s and 1960s, most fighter aircraft were bought at rates of six to ten per month (see Figure 2). In the past five years, only two fixed-wing aircraft--the Air Force's F-16 and the Navy's F/A-18--

FIGURE 2. PRODUCTION RATES FOR TACTICAL AIRCRAFT



SOURCE: Congressional Budget Office using data from G.K. Smith and E.T. Friedmann, *An Analysis of Weapon System Acquisition Intervals, Past and Present*, R-2605 (Santa Monica: The RAND Corporation, November 1980).

were bought at a rate of five or more units per month. Some recent Navy programs, by contrast, plan to buy aircraft at a rate of one or less per month in 1988.3/

The effects of increasing cost on production rates are also manifested in total program quantities for aircraft. Consider the A-6 attack aircraft's production history. Some 479 of the A-6A model were delivered in the nine-year period from 1961 through 1969--an average of 53 a year. Although the improved A-6E model has been in production since 1970, only 195 aircraft have been ordered in 18 years--less than 11 a year. Now, the Navy plans to acquire the upgraded A-6F model, starting with the fiscal year 1988 program, but to buy only 150 over the next six years. If history is any guide, these plans too are likely to be altered downward, stretching procurement of these 150 aircraft over 10 to 12 years.

Impact of the Defense Buildup on Production Rates

Nor has the recent expansion in defense spending always reversed this trend toward lower numbers. Procurement budget authority in fiscal years 1983-1987 was 92 percent higher than in the earlier five-year period from 1976 through 1980, after adjusting for inflation. But this large increase in funds did not result in uniformly higher procurement rates, as is apparent from a comparison of the annual average rates for the identical or comparable systems in the earlier period (see Table B-2 of Appendix B).

For some tactical missiles, procurement rates did increase in the more recent period. Procurement of the Army's TOW antitank missile averaged 15,500 per year over the 1983-1987 period, an increase of 1,000 missiles per year over the 1976-1980 rates. The Standard Missile's order rate nearly doubled, increasing from 449 to 848 per year. Procurement of the Sparrow air-to-air missile increased by about one-third, but procurement of the Sidewinder (another air-to-air missile) decreased slightly.

3. These programs include the EA-6B and E-2C aircraft and the F-14D fighter.

Helicopter procurement rates also increased. The AH-64 Apache attack helicopter was bought at an average of 117 per year over the period 1983 to 1987, versus 61 for its predecessor, the AH-1 Cobra. Procurement of the UH-60 Black Hawk, a transport helicopter, increased to 85 per year, as compared with an average of 64 over the 1977-1980 period. Procurement of the CH-53 Super Stallion, a transport helicopter, increased modestly from 9 to 12 per year.

On the other hand, production rates for strategic weapons were not significantly higher even though strategic modernization was one of the Administration's highest priorities. Procurement of the MX missile was limited by the Congress to an average of 16.5 units per year. But even the Administration's planned MX production rate of 48 per year was less than the 78 Trident missiles produced annually in 1976 through 1980.

Finally, production rates for fixed-wing aircraft introduced before 1976 were sharply lower in the more recent period, despite larger budgets. Average annual procurement of the F-14 fighter/interceptor aircraft decreased from 38 to 21, annual procurement of the P-3 anti-submarine warfare aircraft fell to 8 from 13, and the F-15 fighter aircraft experienced the largest decrease of all, declining from 95 per year to an average of 41.

Production Rates in the Fiscal Year 1988 Budget Request

If past results are mixed, more recent trends seem clearer. Production rates for 11 of the 20 largest programs (excluding ships) in the budget for fiscal year 1988 were reduced from last year's estimate (see Table B-3 in Appendix B). Only 2 of these 20 programs--the Tomahawk missile and the AH-64 helicopter--show a rate increase from last year's estimate. The direction in which many rates are headed seems evident.

CHAPTER III

IMPLICATIONS OF STRETCH-OUTS FOR COSTS AND SCHEDULES

Stretch-outs generally impose a cost penalty on procurement programs, as well as delaying deliveries of weapons to the military forces. Sometimes, however, good reasons exist to slow or defer production in specific cases. These considerations need to be balanced against the cost penalties and deployment delays that stretch-outs impose.

INCREASED PROGRAM COSTS

Stretching out the production of weapons tends to increase both unit and total program costs. Decreasing the basic rate of production for major weapons by 50 percent would increase real unit costs by from 7 percent to more than 50 percent, according to data supplied by the military departments and weapons producers (see Table 3). In the extreme case, according to the Army, procurement unit costs for the TOW 2 missile would increase by 60 percent if Army procurement of this missile were reduced to 6,000 missiles per year. Decreasing MX purchases to a rate of 13 per year would increase costs by 50 percent. Other tactical missiles, such as the IIR Maverick and Phoenix, would experience cost increases of from 8 percent to 43 percent if their production rates were cut in half.

The costs of ongoing aircraft programs, such as the A-6 and the AH-64, appear somewhat less sensitive to production-rate declines. Even for these programs, however, a 50 percent cut in production rates would increase unit costs by 7 percent to 35 percent. Unit cost increases for the two Army vehicles examined--the M1 tank and the Bradley Fighting Vehicle--were estimated at 27 percent and 37 percent, respectively, if annual quantities purchased were reduced by 50 percent.

TABLE 3. SENSITIVITY OF UNIT COSTS TO CHANGES IN PRODUCTION RATES
(Rates in units per year; cost changes in percent)

		Service Estimates				Regression Model
		50 Percent Decrease		50 Percent Increase		50 Percent Increase
System	Basic Rate a/	New Rate	Cost Change	New Rate	Cost Change	Cost Change
			Aircraft			
A-6F Intruder	12	6	16	18	-7	-7
AH-64 Apache	78	39	21	117	n.a.	-6
AV-8B Harrier II	32	16	19	48	-5	-14
CH-47D Chinook	48	24	28	72	-7	b/
E-2C Hawkeye	6	3	24	9	-9	b/
EA-6B Prowler	6	3	17	9	-7	b/
F-14D Tomcat	7	3	13	10	c/	c/
F-15D/E Eagle	48	24	35	72	-13	-1
F/A-18 Hornet	84	42	10	126	-4	-5
KC-135R Tanker	50	25	7	75	-3	-4
SH-60F CV Helicopter	18	9	8	27	-3	-6
			Missiles			
AMRAAM	833	417	30	1,250	c/	c/
Harpoon	124	62	40	186	-15	b/
IIR Maverick	6,000	3,000	27	9,000	-13	b/
MX	26	13	50	39	-18	-26
Patriot	884	442	16	1,326	c/	c/
Phoenix	430	215	14	645	-10	-12
Stinger	4,200	2,100	43	6,300	-14 c/	-7 c/
Tomahawk	475	238	8	713	-3	-1
TOW 2	12,000	6,000	60	18,000	-13	-15
			Vehicles			
M1 Tank	720	360	27	1,080	-15	-8
Bradley Fighting Vehicle	720	360	37	1,080	c/	c/

SOURCES: Congressional Budget Office estimates (for regression model results), U.S. Air Force, U.S. Army, and U.S. Navy.

NOTE: n.a. = not available.

a. The basic rate is the service's proposed quantity for fiscal year 1988 in the case of Army and Air Force systems, and the quantity requested in the fiscal year 1988 budget for Navy systems.

b. Regression model estimate was insignificant.

c. A 50 percent increase in production is not feasible for 1988, according to the service.

On the other hand, increasing quantities above the current rate of production would lower unit costs. A 50 percent increase would decrease unit costs by from 3 percent to 18 percent, depending on the system (see Table 3). Missiles such as the MX, IIR Maverick, and Phoenix appear to offer potential savings of from 10 percent to 18 percent, were production rates boosted by 50 percent. The M1 tank's unit cost would decrease by 15 percent, according to the Army, were its production increased 50 percent to 1,080 units per year. Cost decreases for aircraft programs would be smaller--generally 10 percent or less for a 50 percent rate increase. But 10 percent of a $30 billion aircraft program is $3 billion--not an insignificant sum.

The cost savings obtainable from higher production rates would be smaller--system by system--than the comparable percentage cost increases from reducing rates. This asymmetric pattern results from the observed relationship between costs and production rates (displayed in Figure 1 in Chapter II). At low rates of production, unit cost is very sensitive to changes in the rates, but as one moves along the curve toward higher production rates the relative savings from further increases diminish.

Regression Estimates of the Rate-Cost Relationship

A schedule of increases and decreases in unit cost does not provide a basis for accurate budget estimates over five years; these estimates depend on factors other than the production rate, such as the effect of learning. In order to facilitate making cost estimates for other quantities and budget years, the study used regression models to relate costs to changes in production rates and other factors for a number of programs. These models are based on the previous work of other researchers.1/

1. See John C. Bemis, "A Model for Examining the Cost Implications of Production Rate," *CONCEPTS--The Journal of Defense Systems Acquisition Management*, vol. 4, no. 2 (1981), and Michal Bohn and Louis A. Kratz, *Development of an AFSC Production Rate Variations Model*, Report No. TR-4612-2-2 (Arlington, Va.: The Analytic Sciences Corporation, 1984).

These estimates--like others previously reported--were not always successful in capturing the relationship between cost and production rates. Significant rate effects were found for only about half the programs for which models were fitted. These successful estimates were sometimes higher and sometimes lower than those made by the services, but were comparable overall (see the final column of Table 3 for examples).

In cases where a regression model failed, it was usually because the estimated coefficients were statistically insignificant or had an implausible sign (implying, for example, that unit costs increased as rates increased). In these cases a simpler model was employed, relating unit costs solely to total numbers of weapons bought. The simpler model captured the effects of the "learning curve"--that is, the decline in unit costs as the contractor builds more weapons and learns how to be more efficient--but did not separately capture the effect of buying weapons faster. Although the simpler models still show that speeding up the rate of buy decreases annual unit costs, this is because learning-curve savings are realized more quickly.2/ The estimated effects on costs are usually much smaller than estimates using models that explicitly capture the effects of buy rates. This accounts for the wide range of cost estimates that appear in parts of this study.

Reasons Why Higher Rates Offer Savings

The reductions in unit cost that come through higher production rates stem from many sources. Labor savings are achieved by assigning a larger crew of workers more specific tasks, allowing them to become more proficient, and avoiding delays associated with shifting them from one job to another. Similar savings are possible in the use of

2. An example will clarify this statement. Assume that 100 articles are to be bought. If one uses a simple model that does not capture production-rate effects explicitly, but does capture the effects of the learning curve, total costs in real terms to buy all 100 weapons will be the same regardless of the rate at which they are bought. Average unit costs in, say, the first five years could differ, however. For example, the average unit cost over five years if 20 units are bought each year will be lower than the average unit cost if only 10 are bought a year, because the more rapid rate of production realizes learning-curve savings more quickly. Thus, when analysts compare costs of buying weapons at varying rates over a fixed period of time, unit costs can vary even with a simple learning-curve model.

machinery, since a larger number of units can be run off once a machine is set up to perform a given task. If the rate of production warrants, it may be economical to build special-purpose machines to perform tasks more efficiently than is possible with general-purpose tools. Economies also result when quantity discounts are obtained on purchases of parts and components. Other reductions in unit costs come from spreading fixed production costs (such as for tooling and test equipment) over a larger number of units.

Dollar Savings from Higher Rates

Higher production rates clearly have the potential to reduce the unit costs of weapons. What do lower unit costs mean in terms of potential budget savings? The range of these savings can be illustrated by looking at production rates for two aircraft--the F-15E and F/A-18.

TABLE 4. ESTIMATED SAVINGS UNDER HIGHER PRODUCTION RATES
(Costs in billions of 1988 dollars)

System	Average Annual Production Rates: Administration Plan	Average Annual Production Rates: Alternative Plan	Added Near-Term Costs of Alternative Plan	Net Long-Term Savings	Discounted Present Value of Savings: 2 Percent	Discounted Present Value of Savings: 10 Percent
F-15E Aircraft (Lower Estimate)	38	86	5.2 a/	0.5	0.1	-0.9
F-15E Aircraft (Higher Estimate)	38	86	1.3 a/	2.9	2.3	0.9
F/A-18 Aircraft	73	116	4.5 b/	0.5	0.2	-0.7

SOURCE: Congressional Budget Office estimates of savings, based on program costs reported in Department of Defense, *Selected Acquisition Reports* (December 1986).

a. Through 1991.

b. Through 1990.

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F-15E Eagle Fighter Aircraft. The Air Force plans to buy 342 F-15E fighter aircraft from the McDonnell Douglas Corporation over the period 1988-1996 at an estimated total cost of $12.4 billion. The rate of production under the Air Force's plan averages 38 aircraft per year. It could instead buy these aircraft at a rate of about 7 per month (86 per year), still well below McDonnell Douglas's maximum economic production rate of 12 a month. This approach would save from $0.5 billion (assuming little rate effect) to as much as $2.9 billion (using the higher service estimate for the rate effect) over the life of the program (see Table 4).

F/A-18 Hornet Fighter/Attack Aircraft. The Navy recently chose to reduce the annual rate of procurement of F/A-18s to an average of 73 aircraft per year. In contrast, the acquisition plan presented with the fiscal year 1987 budget called for an increase to the maximum economic production rate of 132 aircraft per year.

The present Navy plan is estimated to cost $15.3 billion for the 580 aircraft needed to complete the F/A-18 program. If these aircraft were bought instead at an average of 116 aircraft per year, a net savings of $0.5 billion could be realized. This plan, however, would require that $4.5 billion in additional budget authority be granted to the Navy over the 1988-1992 period.

Discounted Net Savings

As these examples suggest, more rapid acquisition programs entail higher near-term budgets but lead to net savings over the life of the program. For a proper assessment of the cost-effectiveness of increasing production rates, the savings have to be discounted to reflect the reality that future budget dollars are worth less than current ones.3/ If the net discounted present value of long-term savings exceeds the near-term costs, then the higher rates more than pay for themselves in the long run.

At CBO's preferred real discount rate of 2 percent, the net present value of savings for the three estimates described above is positive--

3. The effects of inflation have already been removed by expressing all system costs in constant dollars.

suggesting that higher production rates reduce costs even after discounting (see Table 4). The services sometimes use higher real discount rates of as much as 10 percent in their program analyses.4/ At a rate of 10 percent, two of the three cases have negative discounted present values, suggesting that higher rates do not achieve savings. A discount rate of 10 percent is extremely high given current economic conditions. A rate of 2 percent better reflects more recent experience.

OTHER REASONS TO AVOID STRETCH-OUTS

Debate over the rate of production of weapons systems tends to focus on the economic issue, particularly the negative impact of lower rates on unit and total program cost. But avoiding stretch-outs by maintaining high production rates would offer other benefits as well.

Completing acquisition programs faster could limit the effects of technological obsolescence. Table 5 shows the number of years that would be required to meet DoD objectives for acquiring 26 selected weapons systems at the procurement rates planned for 1989. (The 1989 rates were chosen over those for 1988, because in most cases they were more typical of planned rates.) The table also shows the number of years these systems have already been in production. If planned 1989 rates were to continue, it would take an average of 16 years from the start of production to meet DoD's objectives; for 6 of the 26 systems, it would take 20 years or more. While many of these systems have been modified during these long production periods, there are limits to what these modifications can do to meet increasing foreign threats.

Completing the acquisition of weapons systems sooner would also make room in future budgets for new weapons. For example, 35

4. The Office of Management and Budget, in its Circular A-94 (published in 1972), directed all federal agencies to use a discount rate of 10 percent, after expressing costs and benefits in constant dollars, for all program analyses submitted to OMB for approval. It also suggested, but did not mandate, the use of this rate in internal agency analyses. Since then other circulars, oriented toward more specific cases, have specified other discounting rules, some of which use lower discount rates. But Circular A-94 has been neither revised nor rescinded, and still reflects Administration policy for selecting the discount rate in the absence of more specific instructions.

TABLE 5. YEARS TO ACQUIRE SELECTED MAJOR WEAPONS SYSTEMS

System	Total Program Quantity	Needed to Complete	Years in Production	Procurement Rates 1988	Procurement Rates 1989	Years to Complete a/	Total Years
AMRAAM Missile b/	24,320	24,140	1	630	1,800	14	15
AV-8B Aircraft	328	148	6	32	32	5	11
A-6E/F Aircraft	345	150	18	12	18	9	27
Bradley Fighting Vehicle	6,882	2,549	8	616	618	5	13
CH/MH-53E Helicopter	153	32	11	14	14	3	14
E-2C Aircraft	141	30	17	6	6	5	22
EA-6B Aircraft	80	42	4	6	9	5	9
F-14A/D Aircraft	710	132	17	12	12	11	28
F-15A/D/E Aircraft	1,266	342	15	42	42	9	24
F-16A/B/C/D Aircraft	2,729	1,230	10	180	180	7	17
F/A-18 Aircraft	1,157	580	9	84	72	8	17
HARM Missile b/	14,619	7,098	7	2,514	2,659	3	10
Harpoon Missile	3,971	886	13	124	138	7	20
Hellfire Missile c/	48,696	27,614	6	5,000	4,000	7	13
IIR Maverick Missile d/	60,664	50,744	6	2,100	1,900	27	33
M1 Tank	7,844	2,086	9	600	534	4	13
Multiple Launch Rocket System	440,322	180,000	8	72,000	36,000	5	13
MX Missile	235	169	4	21	21	8	12
Patriot Missile	6,452	3,602	8	715	815	5	13
Phoenix Missile	7,204	5,904	8	430	560	11	19
SH-60F Helicopter	175	168	1	18	18	10	11
Standard Missile 2	14,677	9,375	12	1,150	1,635	6	18
Stinger Missile c/	50,370	31,631	10	4,200	5,000	7	17
Tomahawk Missile	3,994	2,958	8	475	510	6	14
TOW 2 Missile c/	125,856	48,623	7	9,416	8,719	6	13
UH-60 Helicopter c/	1,111	252	11	61	72	4	15

SOURCE: Congressional Budget Office computations based on DoD data contained in Congressional Data Sheets, *Selected Acquisition Reports*, and *Procurement Programs (P-1)*.

a. Based on 1989 rate.

b. Combined Air Force-Navy procurement.

c. Army procurement only.

d. Air Force (AGM-65D/G) version only.